The Second Tibetan Plateau Scientific Expedition and Research (STEP)

Supraglacial lake outburst floods in the China-Nepal border this July

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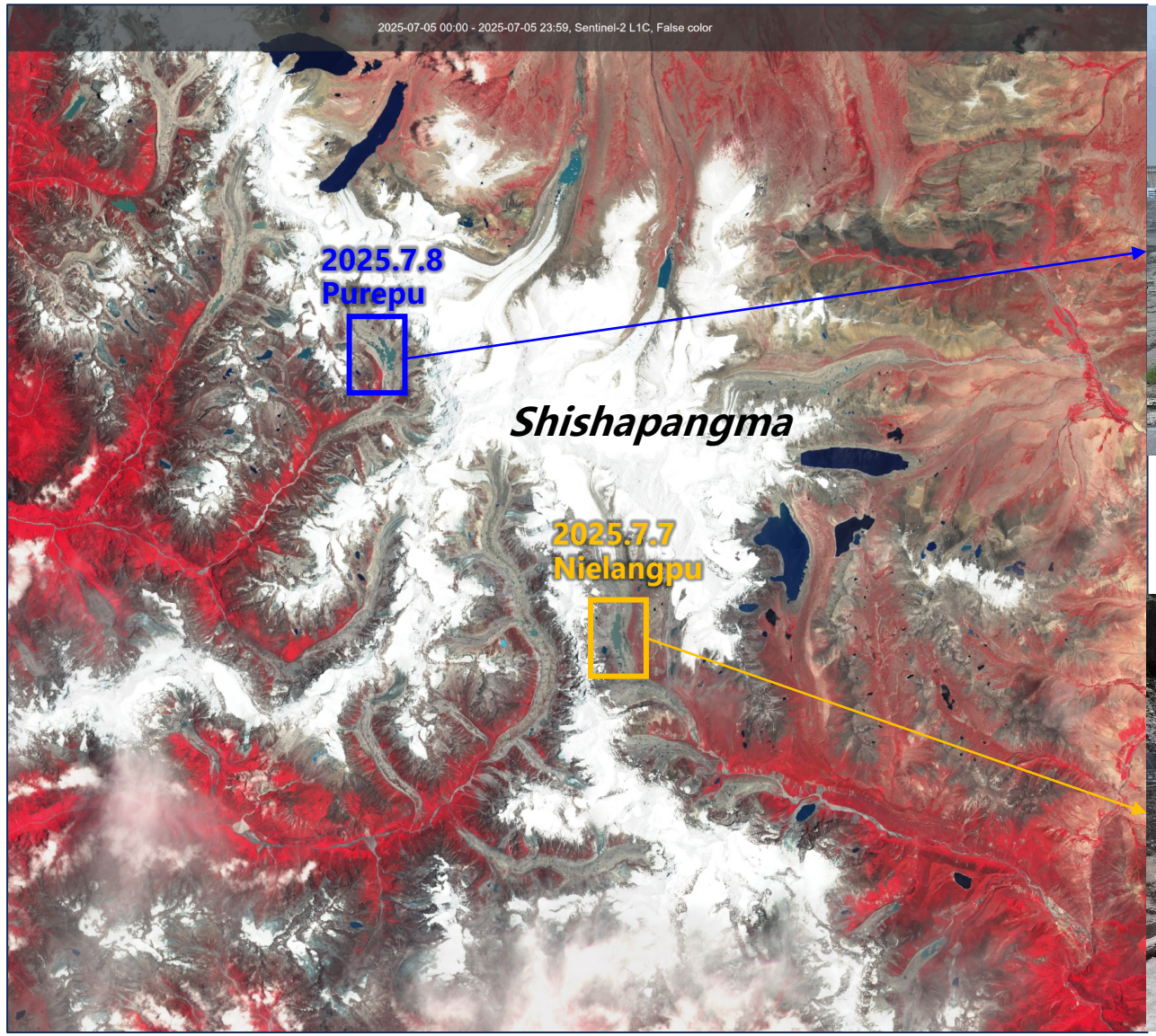
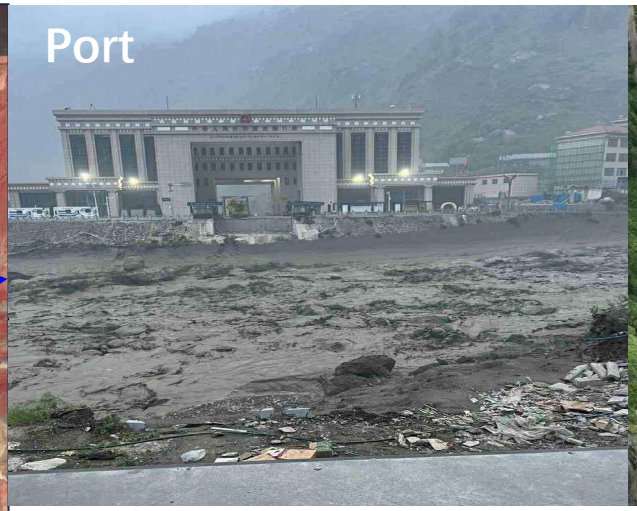
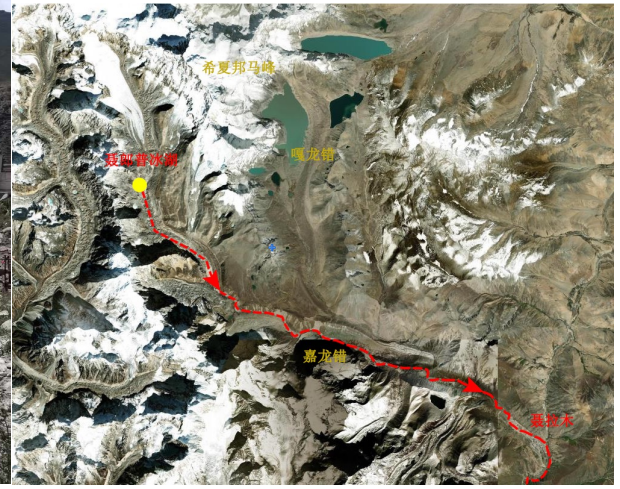
Two supraglacial lake outburst flood happened in China-Nepal border







Nielangpu GLOF on 7July

The GLOF reached Nyalam County **at ~08:00 local time** on 7 July. Owing to the timely warning and the limited flood magnitude, **no casualties or infrastructure damage** were reported

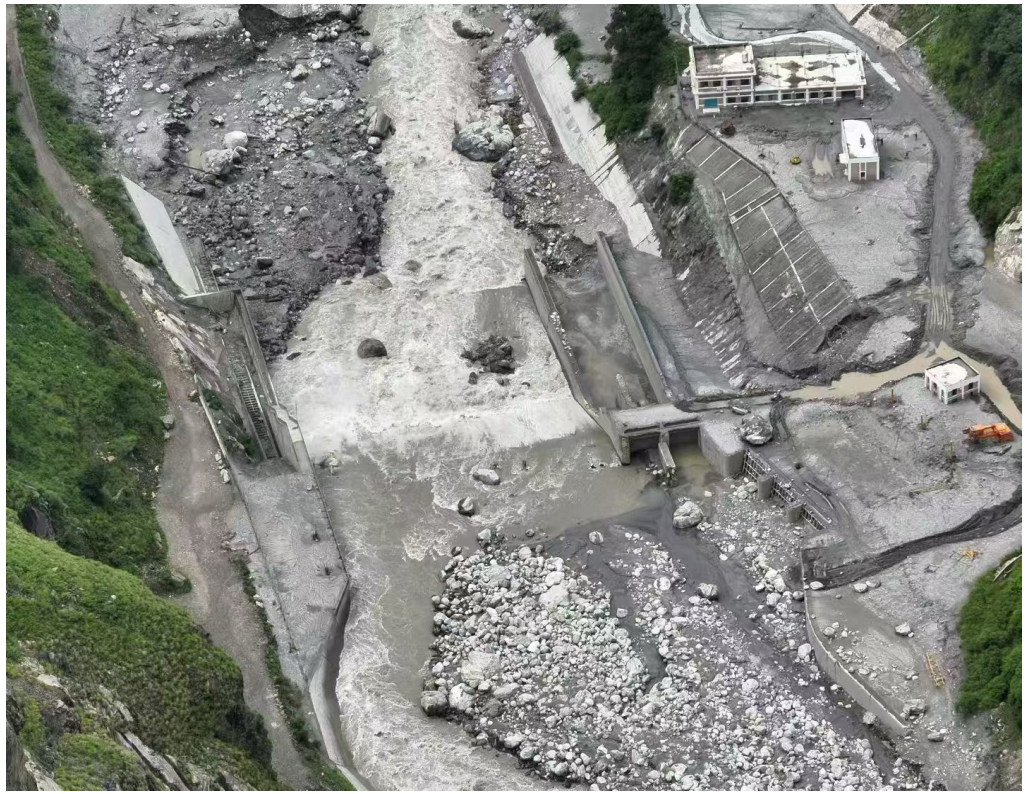
Locations of Nielangpu supraglacial lake and Nyalam County

Partial river Embankments were washed away

Purepu GLOF on 8 July

The GLOF reached Gyirong Port **at ~05:00 local time** on 8 July. At least **18 fatalities** were reported, and thousands of residents were evacuated in this event. Many bridges, roads, and **hydropower projects** were ruined, causing a direct economic loss of **USD 53 million**.

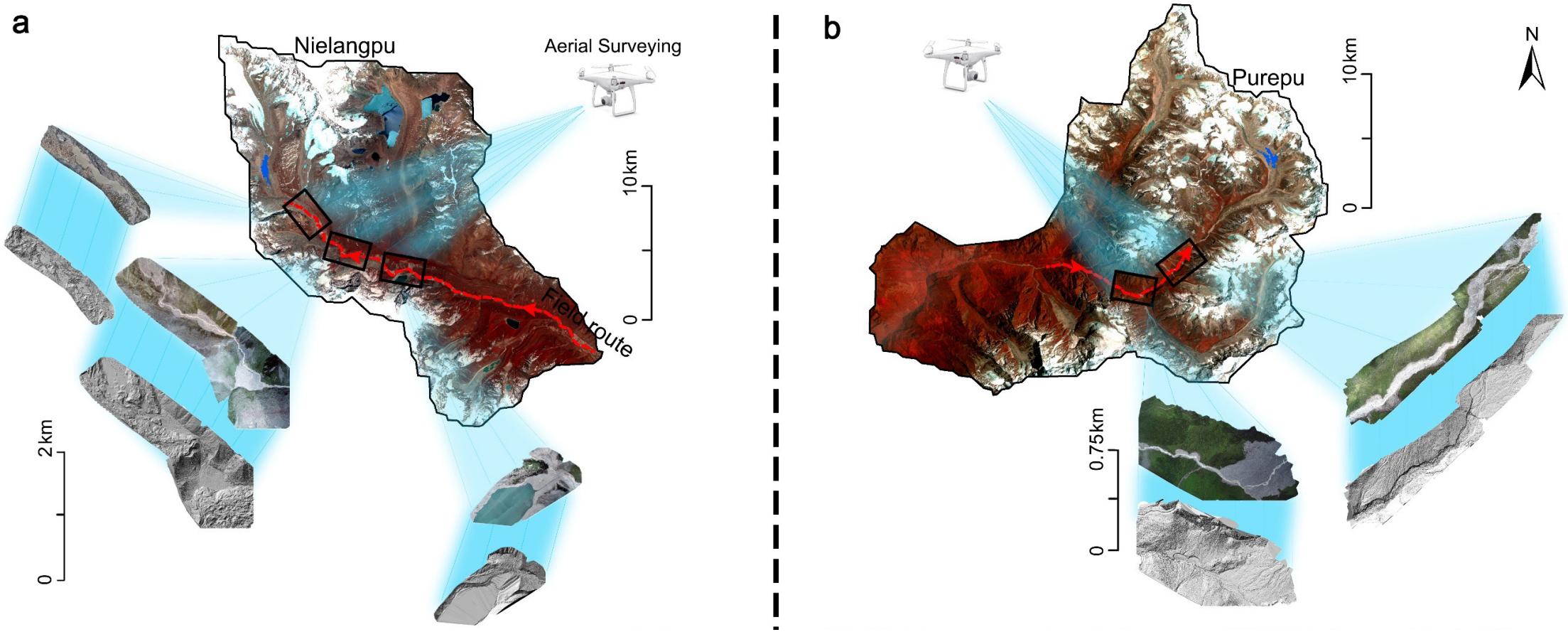
Locations of Purepu supraglacial lake and Gyirong Port



Destroyed hydropower plant

Field campaigns after the GLOFs

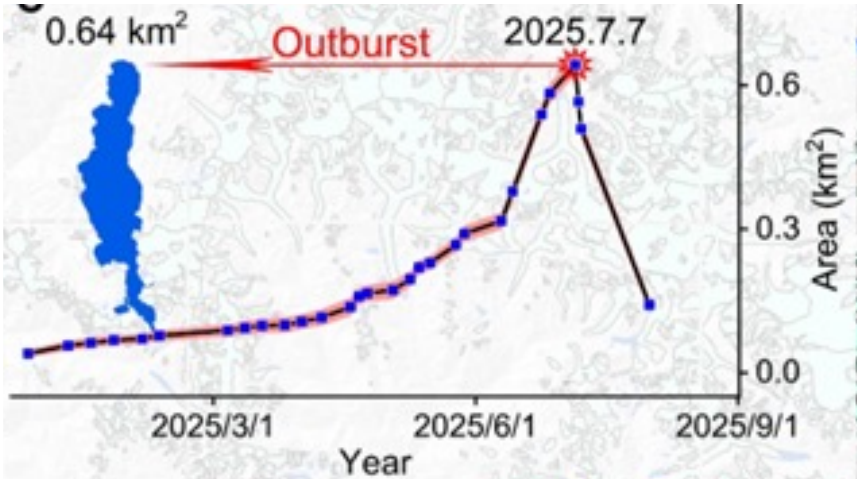
Between 14 to 22 July, we conducted disaster investigations in the Boiqu and Gyirongzangbu basins, aiming to document the two GLOFs and visit the breached supraglacial lakes. By combining with remote sensing data, we have preliminary understanding of the formation and outburst of glacial lakes.



Nielangpu

Rapid growth of Nielangpu supraglacial lake

From January to late April 2025, the Nielangpu supraglacial lake area increased slowly. Thereafter, the lake experienced a near-exponential growth, **reaching 0.64 km² by 7 July**, equivalent to an expansion rate of 7300 $m^2 \cdot d^{-1}$



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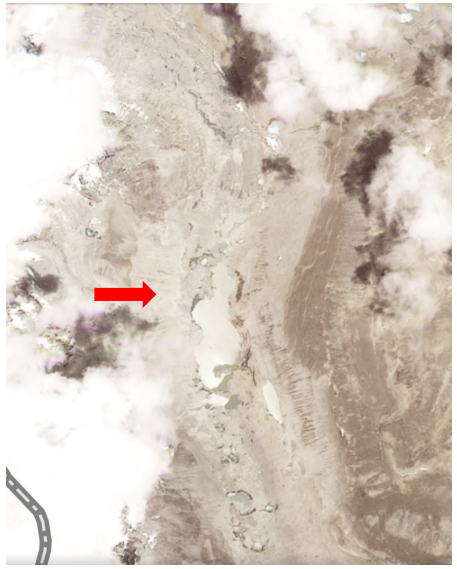

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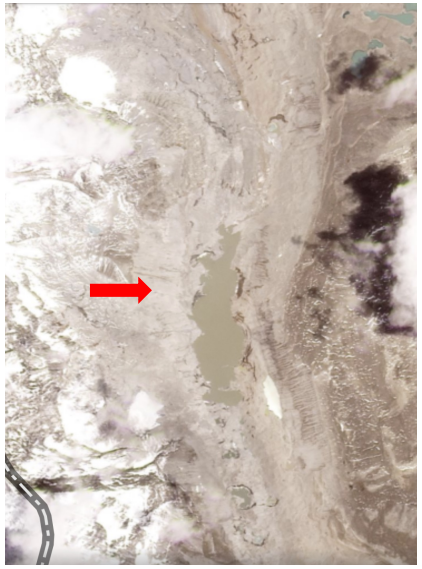

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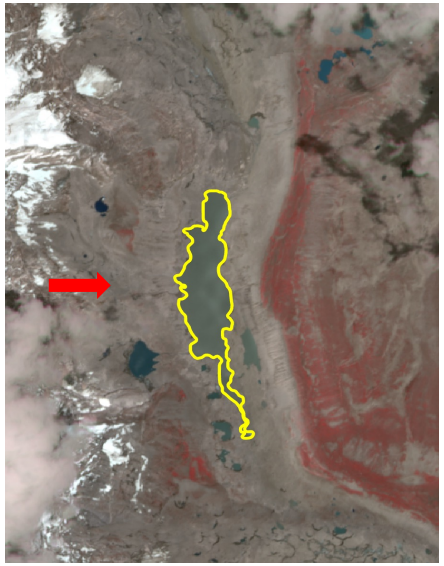
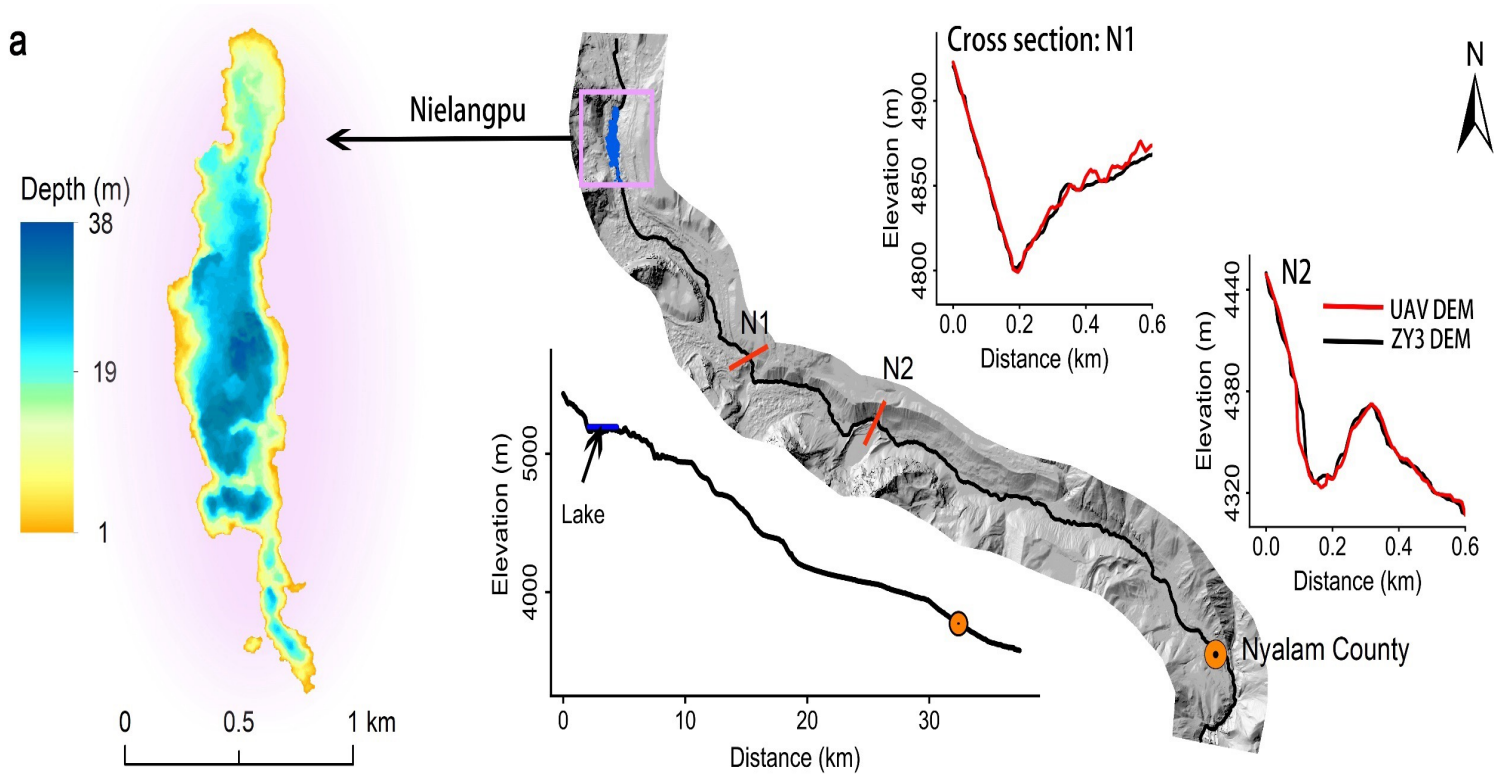


Nielangpu

GLOF characteristics

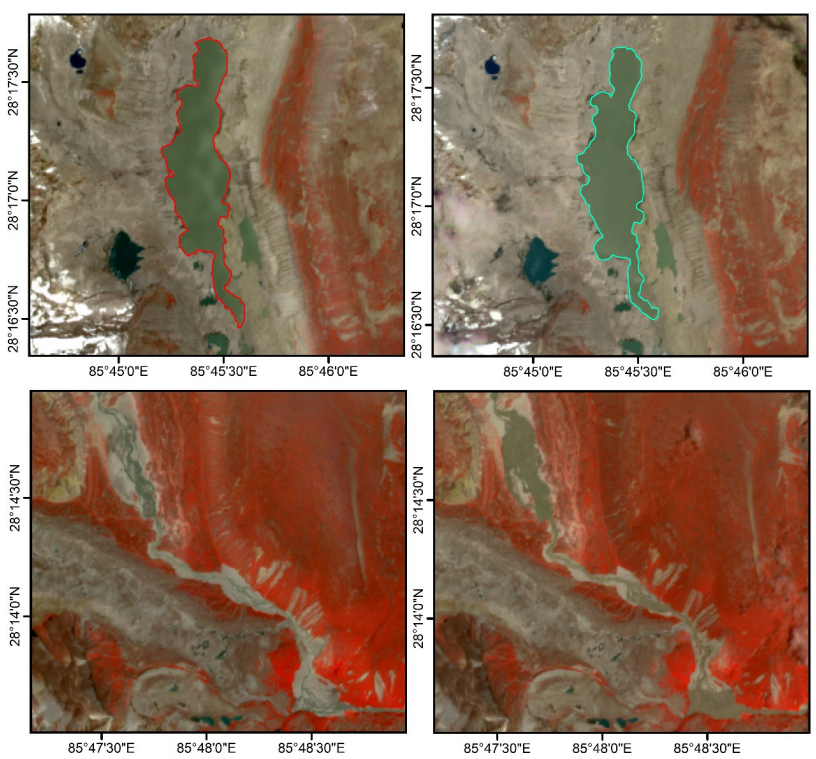
- The bathymetry of the Nielangpu supraglacial lake showed a total volume of **11.8×10^6 m^3** before outburst.
- After outburst, the lake area had decreased to 0.51 km^2. This implies a rapid release of **3.8×10^6 m^3** of water.

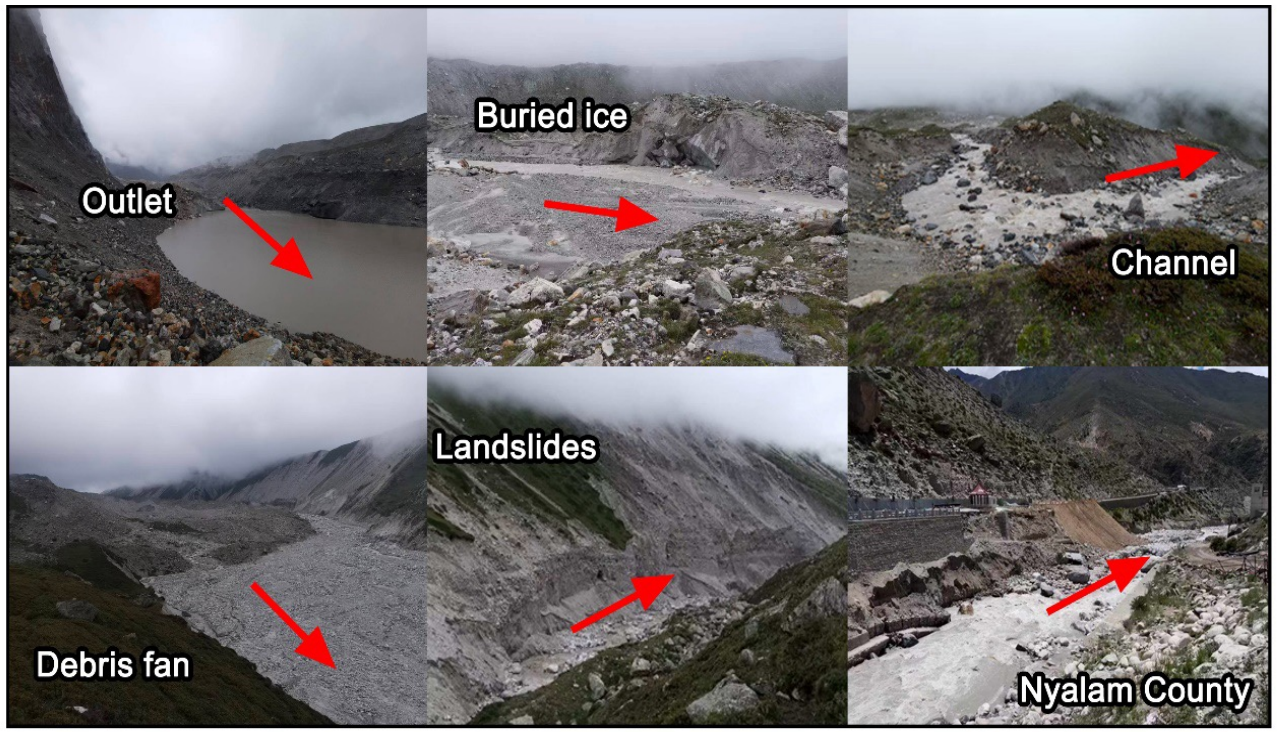


Nielangpu

GLOF characteristics

- The initial rapid discharge caused downstream river overtopping, submerging approximately **1.67±0.46 km²** of floodplain.
- Post-event field investigations identified several active, small-scale landslides along the upstream riverbanks, yet **no obvious channel erosions** were generated.



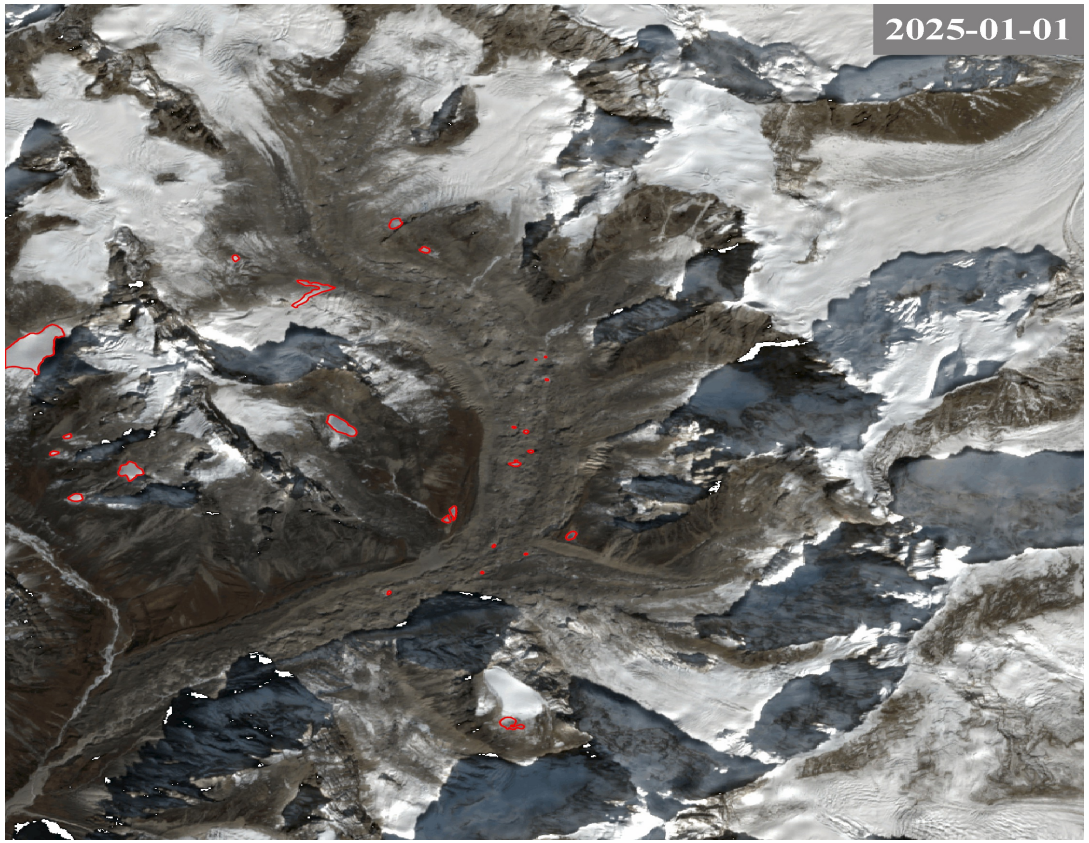


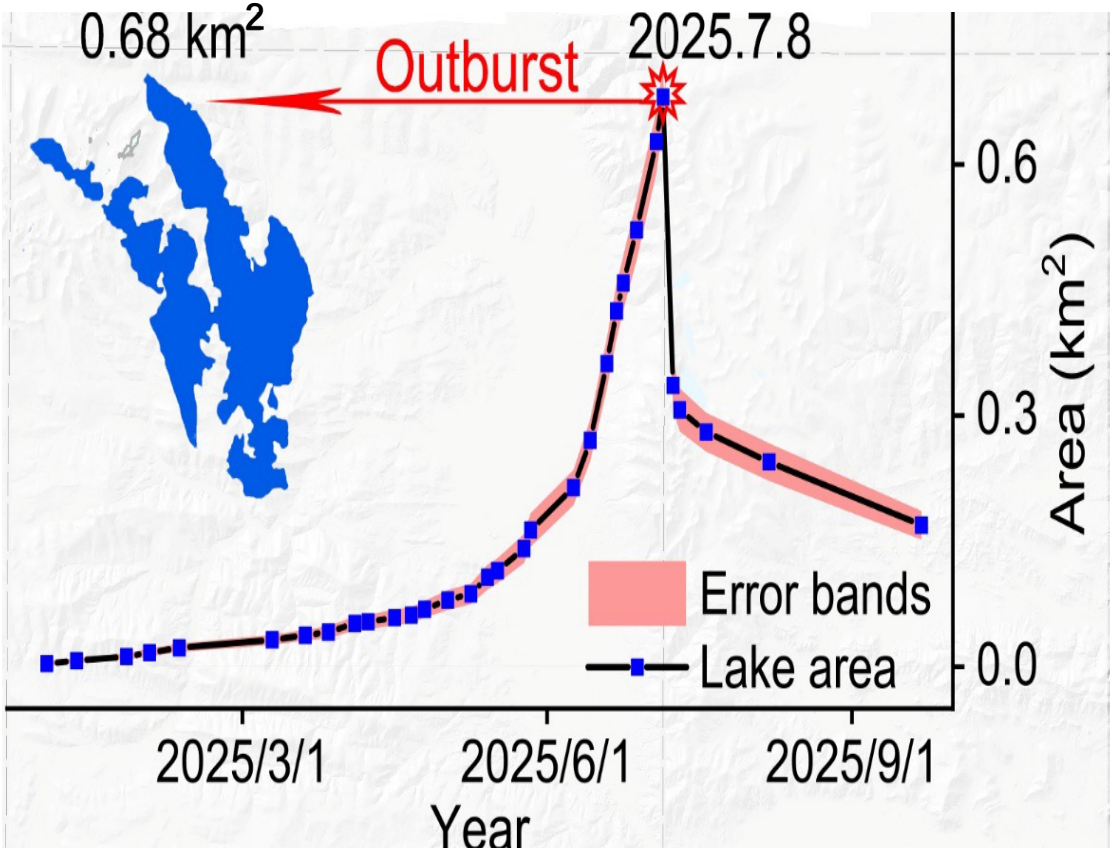
Comparison of the lake and the downstream river channel before and after the outburst

Purepu

Rapid growth of Purepu supraglacial lake

Between January and late April 2025, the Purepu supraglacial lake expanded slowly at a rate of 500 $m^2 \cdot d^{-1}$, before transitioning into an exponential growth phase with an expansion rate of 9800 $m^2 \cdot d^{-1}$. The pre-failure lake area **reached 0.68±0.03 km²** on 8 July.

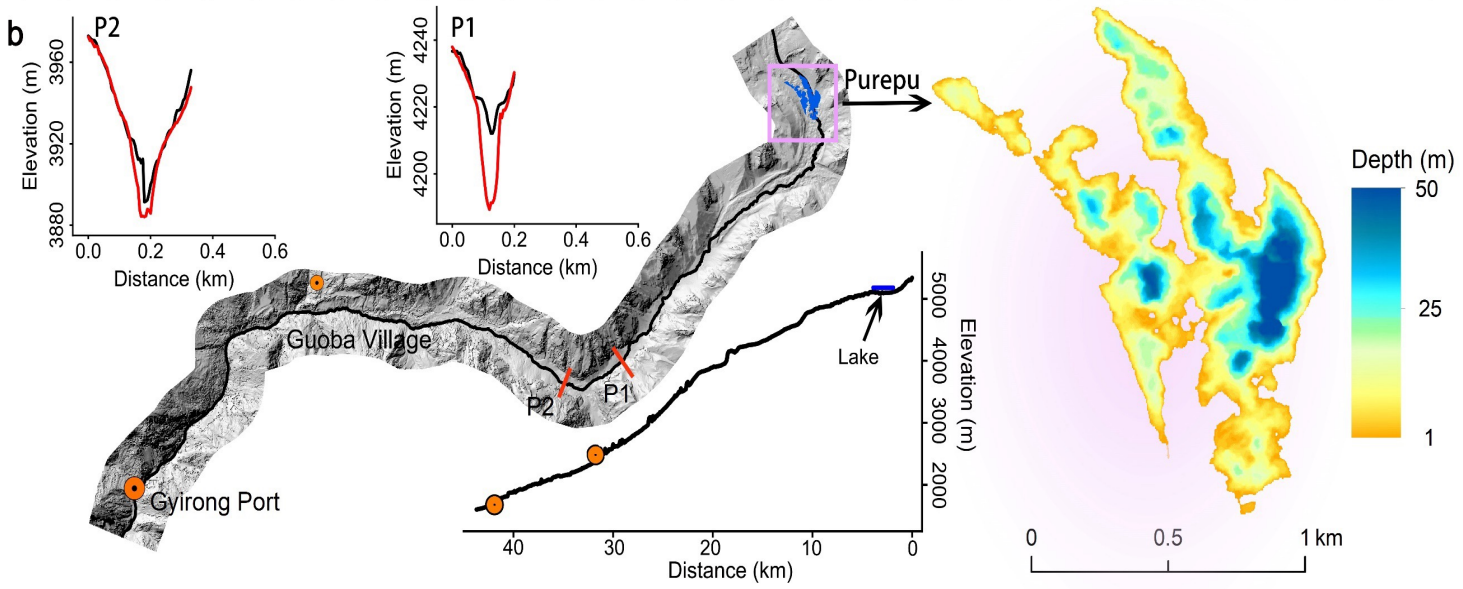


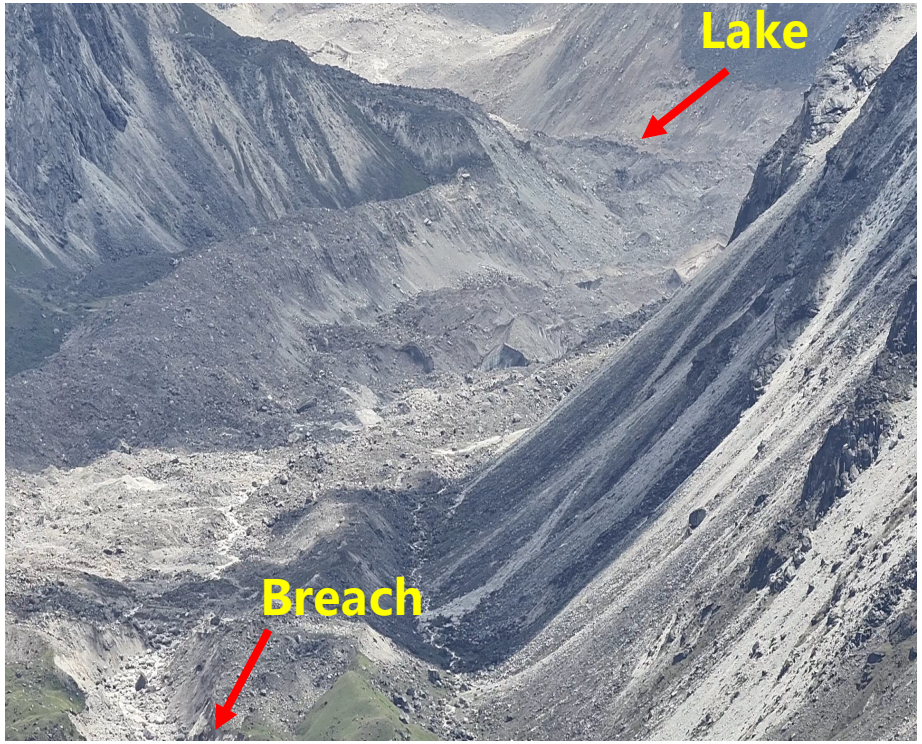


Purepu

GLOF characteristics

- The lake volume was estimated to be **9.1×10^6 m^3** and the maximum water depth reached **50 m** before outburst.
- After outburst, the residual lake area had decreased to 0.34 km^2, indicating a release of **7.2×10^6 m^3** of water.

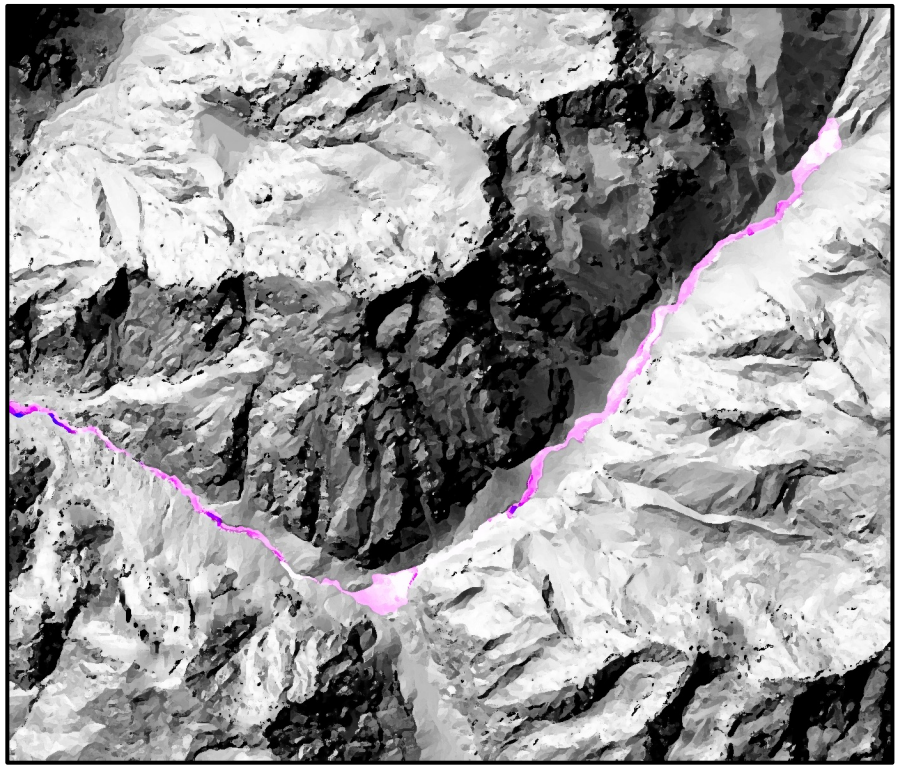




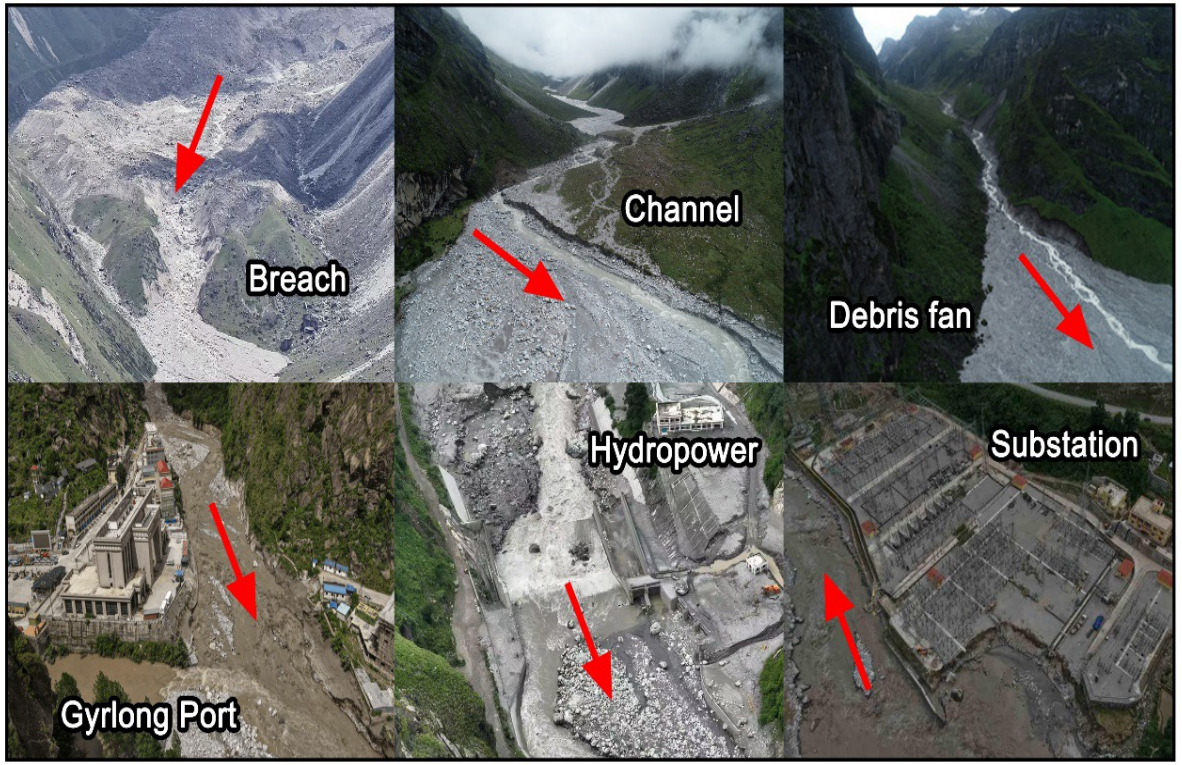
Purepu

GLOF characteristics

- The GLOF was found to have widened the channel by **0.96 km²** (previously covered by grassland and forest) along a 33 km stretch from the breach site to Gyirong.
- Several local incisions of the riverbed reached depths of nearly 23 m. The entrained sediment volume reached approximately **45×10⁶ m³**. At least **20 new landslides** were triggered along the river corridor.

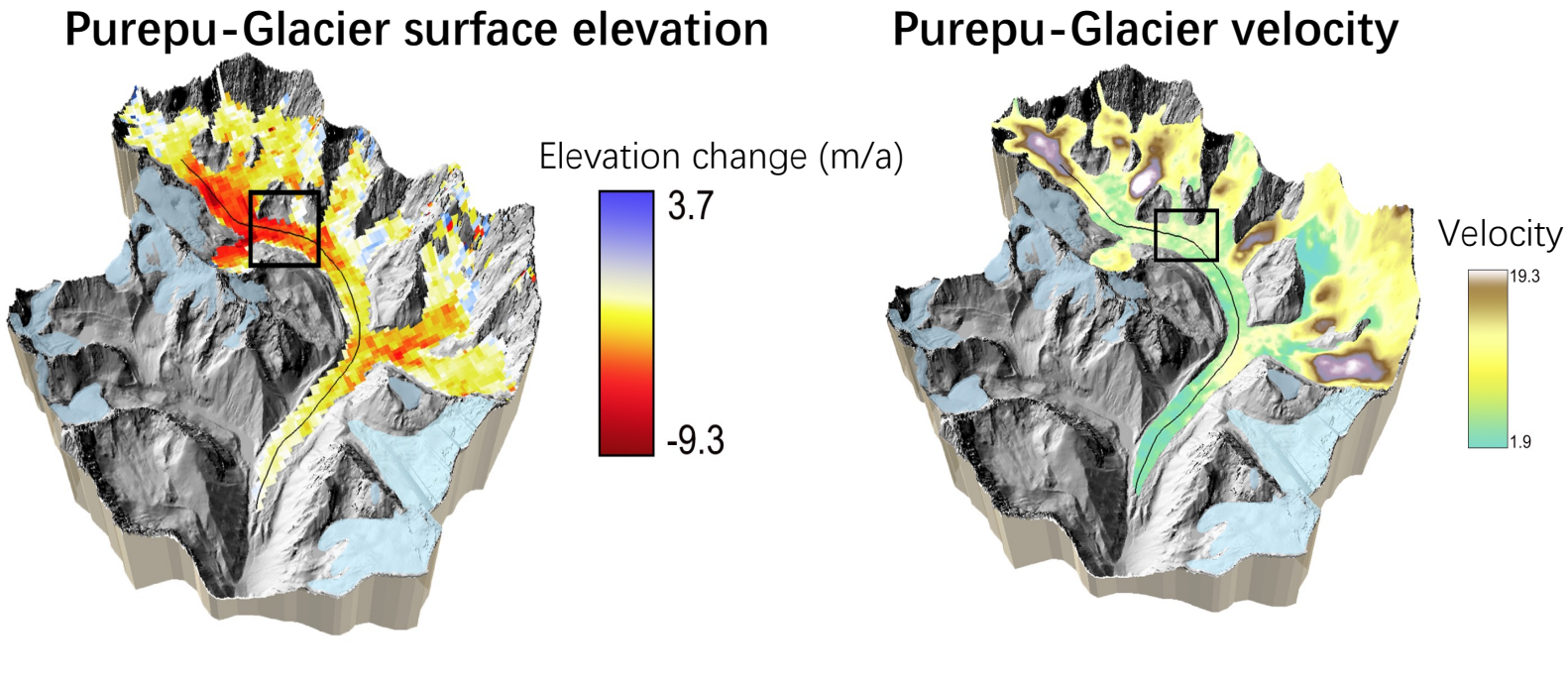


Channel erosion and society damage

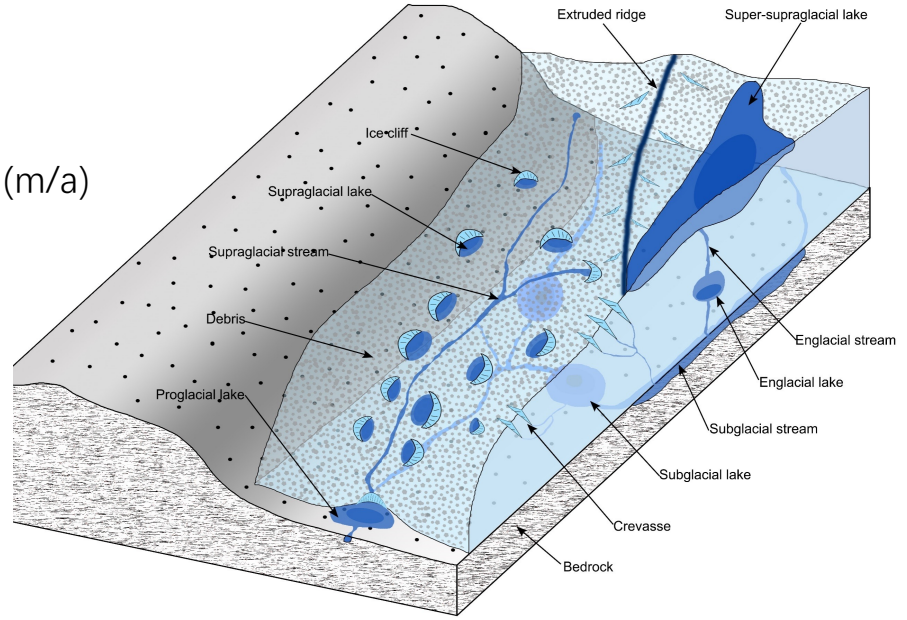


Why did such giant supraglacial lakes form?

Differential glacier downwasting and the blockage caused by tributary glaciers



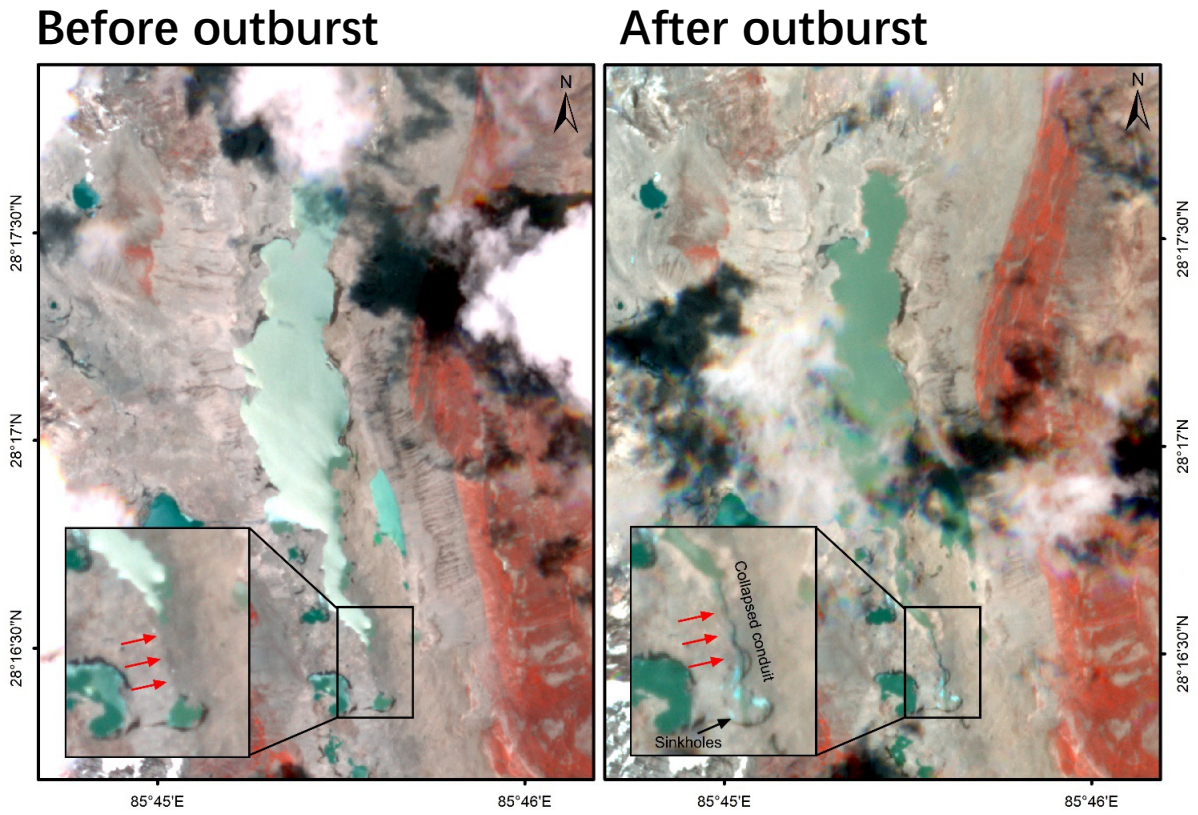
Glacier surface elevation and velocity



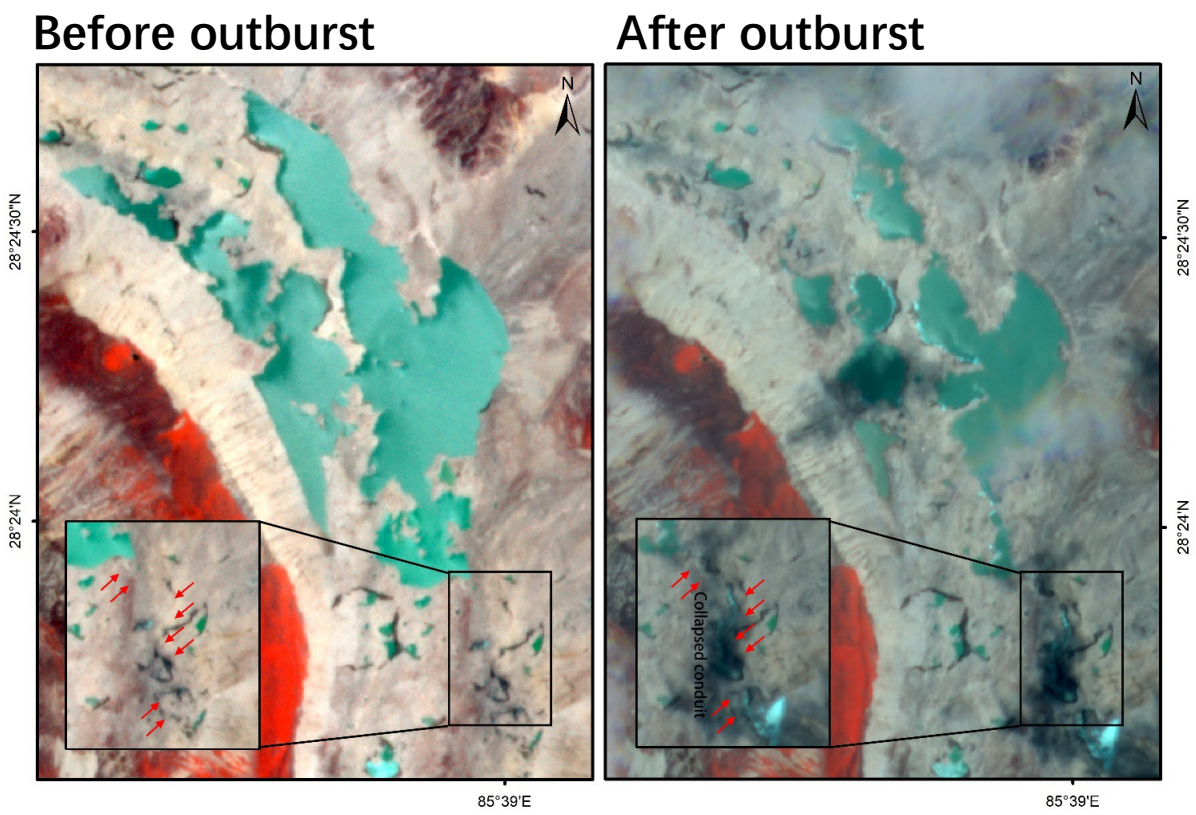
Conceptual diagram of lake formation

Outburst mechanisms of the two lakes

- Drain through subglacial and englacial drainage systems
- Immense hydrostatic pressure built up against the forward ice dam and induced hydrofracturing



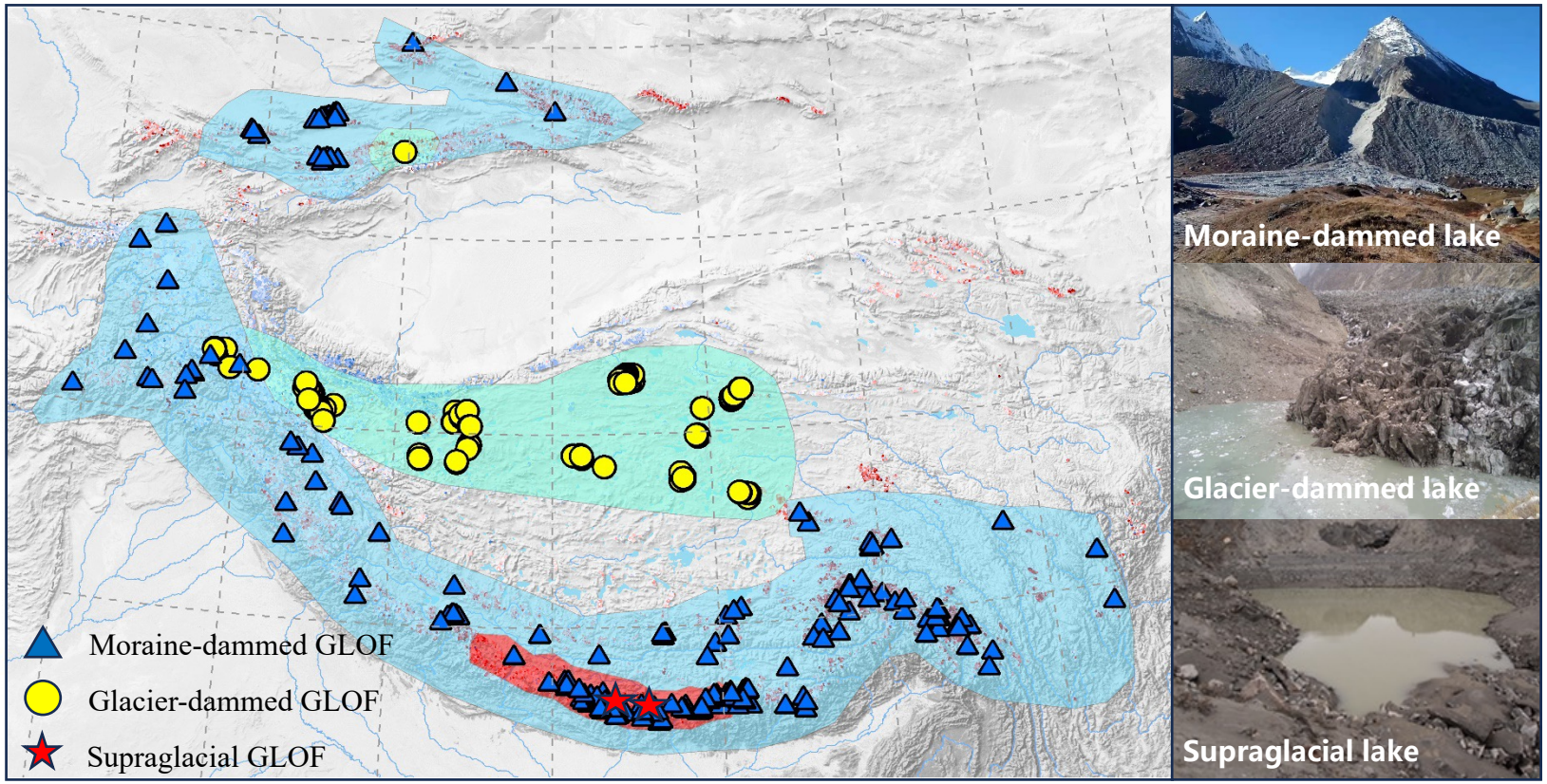
Nielangpu supraglacial lake



Purepu supraglacial lake

Distribution pattern of GLOFs on the Tibetan Plateau

GLOF originating from occasional giant supraglacial lakes is a new type of GLOF



1. High magnitude: The pre-failure lake area is one order of magnitude than other counterparts

2. Heavy destructiveness: Characterized by flash floods, with strong impact downstream

3. Periodic drainage: Formed and drained because of glacier melting and englacial drainage conduits opening.

Thanks for your attention !